

REMARKS

The amendment to the independent claims (claims 1, 12 and 24) is supported by Figure 2. No new matter has been added. Upon entry of this amendment, claims 1, 2, 4-8, 12-16 and 24-26 are present and active in the application.

Applicants would like to thank Examiner Lee for the withdrawal of the final action of July 28, 2003, and withdrawal of the advisory action of March 1, 2004. Applicants would also like to thank Examiner Lee for the courteous and helpful discussion held with applicants' representative on June 17, 2004. During this discussion it was noted that the present invention measures pattern density before calculating or polishing, while Saka et al. carry out all measurements during polishing.

Request For Reconsideration

Chemical mechanical polishing (CMP) is a recognized process for making the upper surface of a dielectric on a semiconductor device planar. In a typical CMP process a wafer is subject to an initial polish for an estimated amount of time such that the thickness does not go below a targeted value. The resulting thickness of the layer is then measured, and using this measured thickness and the initial polishing time, a polish rate is calculated. Finally, the wafer is polished for a time that is calculated to achieve the desired final thickness based on the polish rate.

This process has disadvantages, mainly due to the manual estimates and calculations that are required. Inconsistent thickness targeting can lead to poor process control. It is difficult to account for other parameters which affect the CMP, such as incoming dielectric thickness pattern density, removal rate, and pad hours. Thus, it is difficult to track the overall process to determine the source of errors. The present invention mitigates these problems.

As now claimed, the present invention includes measuring a pattern density of a layer followed by calculating a polish time sufficient to planarize the layer, or polishing with a system. This allows for controllably targeting the thickness of a layer by making use of the recognition that the polishing time has two primary components: (i) the time

necessary to planarize the layer, and; (ii) the time necessary to reduce the thickness of the planarized layer.

The rejection of the claims under 35 U.S.C. § 103 over Kim et al. in view of Saka et al., and optionally further in view of Maekawa, is respectfully traversed. The applied references fail to suggest measuring pattern density prior to calculating polish time or polishing.

Kim et al. describes a method and apparatus that calculates the effective pattern density of a planarization layer prior to and following the polishing process. The layout data that defines the patterned layer of an integrated circuit is generated (column 6, lines 25-32). This calculated pattern density is used to further calculate the thickness of the planarization layer prior to and after the CMP (col. 6, lines 33-34; col. 9, line 61, to col. 10, line 2).


Saka et al. describes an *in situ* method and apparatus for end point detection in chemical-mechanical polishing. The method includes detecting the differences in reflectance between different materials (col. 4, lines 18-24). The differences in reflectance are used to indicate that the top or bulk material has been removed (col. 4, lines 24-26). This allows real time control of the CMP process (col. 4, lines 26-28). There is no suggestion to measure reflectance prior to polishing; the measurement are only used during polishing to determine the end point of the CMP process.

Maekawa teaches that the Cpk value has been monitored in CMP processes, obtaining a process with a Cpk of at least 1.

In contrast, the present invention as now claimed measures the data related to the wafer to be treated, prior to calculating polish time, or prior to polishing. The data may be used to calculate the polishing time needed for planarizing the layer and further reduce its thickness while maintaining its planarity. Neither Kim et al. nor Maekawa suggest measuring pattern density prior to calculating or polishing. Saka et al. does measure reflectance, but this is done during polishing to detect an endpoint to the CMP process; there is no suggestion to carry out any measurements prior to calculating or polishing. Consequently, applicants submit that the claimed invention is not obvious over the applied references. Withdrawal of these grounds of rejection is respectfully requested.

Applicants submit the application is now in condition for allowance. Early notice of such action is earnestly solicited.

Respectfully submitted,

A handwritten signature in black ink, appearing to read 'Paul E. Rauch', is written over a horizontal line.

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